

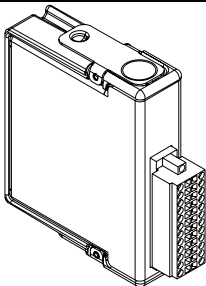
OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9235/9236

8-Channel, 24-Bit Quarter-Bridge Analog Input Module

Français Deutsch 日本語 한국어 简体中文

ni.com/manuals



This document describes how to use the National Instruments 9235 and National Instruments 9236 and includes specifications and terminal assignments. In this document, the NI 9235 and NI 9236 are referred to inclusively as the NI 9235/9236. Visit `ni.com/info` and enter `rdsoftwareversion` to determine which software you need for the modules you are using. For information about installing, configuring, and programming the system, refer to the system documentation. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.



Note The safety guidelines and specifications in this document are specific to the NI 9235/9236. The other components in the system might not meet the same safety ratings and specifications. Refer to the documentation for each component in the system to determine the safety ratings and specifications for the entire system. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Safety Guidelines

Operate the NI 9235/9236 only as described in these operating instructions.



Hot Surface This icon denotes that the component may be hot. Touching this component may result in bodily injury.

Safety Guidelines for Hazardous Locations

The NI 9235/9236 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4, and Ex nA IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the NI 9235/9236 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.



Caution Do *not* disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.



Caution Do *not* remove modules unless power has been switched off or the area is known to be nonhazardous.



Caution Substitution of components may impair suitability for Class I, Division 2.



Caution For Zone 2 applications, install the system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.



Caution For Zone 2 applications, connected signals must be within the following limit:

Capacitance 0.2 μ F max

Special Conditions for Hazardous Locations Use in Europe

This equipment has been evaluated as Ex nA IIC T4 equipment under DEMKO Certificate No. 07 ATEX 0626664X. Each module is marked Ex II 3G and is suitable for use in Zone 2 hazardous locations. If you are using the NI 9235/9236 in Gas Group IIC hazardous locations or in ambient temperatures of $-40\text{ }^{\circ}\text{C} \leq T_a \leq 70\text{ }^{\circ}\text{C}$, you must use the device in an NI chassis that has been evaluated as EEx nC IIC T4, Ex nA IIC T4, or Ex nL IIC T4 equipment.

Special Conditions for Marine Applications

Some modules are Lloyd's Register (LR) Type Approved for marine applications. To verify Lloyd's Register certification, visit ni.com/certification and search for the LR certificate, or look for the Lloyd's Register mark on the module.



Caution To meet radio frequency emission requirements for marine applications, use shielded cables and install the system in a metal enclosure. Suppression ferrites must be installed on power supply inputs near power entries to modules and controllers. Power supply and module cables must be separated on opposite sides of the enclosure and must enter and exit through opposing enclosure walls.

Connecting the NI 9235/9236

The NI 9235/9236 has a 24-terminal detachable spring-terminal connector that provides connections for 8 analog input channels.

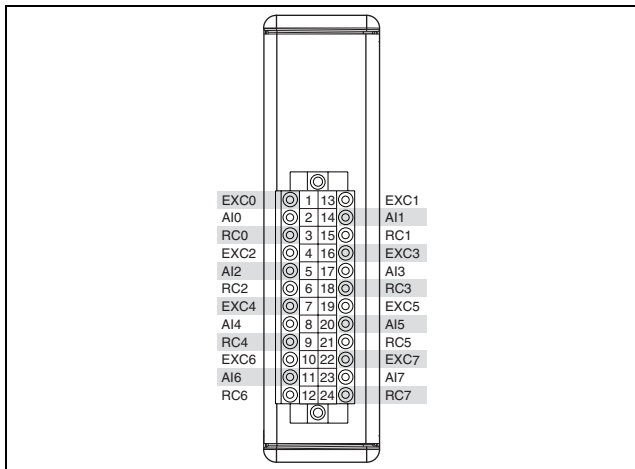
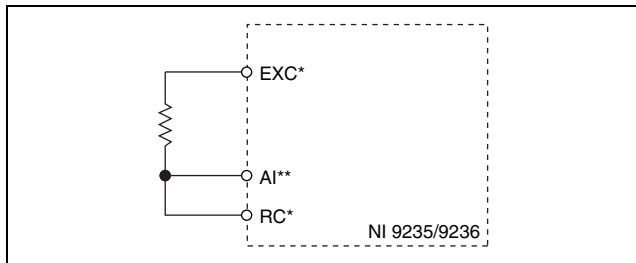


Figure 1. NI 9235/9236 Terminal Assignments

You can connect a quarter-bridge sensor to each channel. Each channel has an EXC terminal that provides the excitation voltage stimulus, an AI terminal that measures the bridge voltage, and an RC terminal that provides the quarter-bridge completion. Refer to Figure 2 for an illustration of how to connect quarter-bridge sensors to the NI 9235/9236.



* For best system accuracy, set up the connections to EXC and RC with equal lengths of an identical wire type and gauge.

** For best system accuracy, set up the connection to AI directly at the sensor instead of shorting AI to RC directly at the terminals.

Figure 2. Quarter-Bridge Connections for the NI 9235/9236

Connecting Wires to the NI 9235/9236 Connector

Use a flathead screwdriver with a blade smaller than 2.3×1.0 mm (0.09×0.04 in.) to connect wires to the detachable spring-terminal connector. Insert the screwdriver into a spring clamp activation slot and press a wire into the corresponding connector terminal, then remove the screwdriver to clamp the wire into the terminal. Refer to the *Specifications* section for more information about spring-terminal wiring.

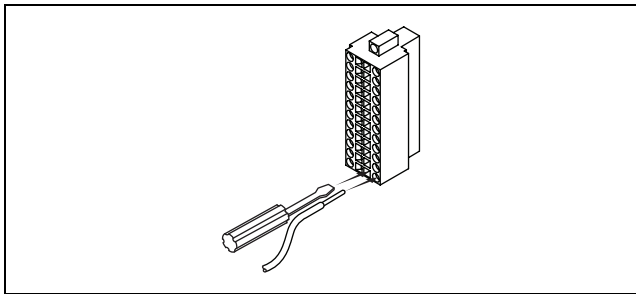


Figure 3. Connecting Wires to the NI 9235/9236 Connector

Wiring for High-Vibration Applications

If an application is subject to high vibration, National Instruments recommends that you use the NI 9965 backshell kit to protect the connections. Refer to Figure 4 for an illustration of the NI 9965 connector backshell.

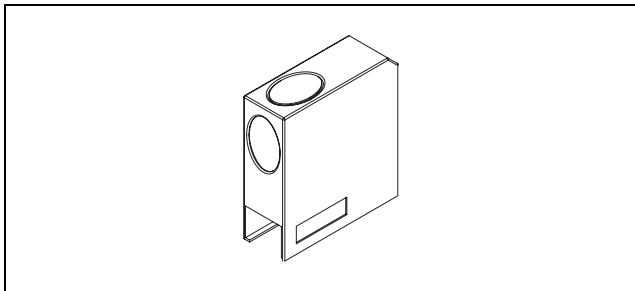


Figure 4. NI 9965 Connector Backshell

NI 9235/9236 Circuitry

The NI 9235/9236 is isolated from earth ground. However, the individual channels are not isolated from each other. The EXC terminals all connect internally to a common excitation supply. You must connect each EXC terminal to only one gage to maintain the channel-to-channel crosstalk performance of the module.

Each channel on the NI 9235/9236 has an independent 24-bit ADC and input amplifier that enables you to sample signals from all eight channels simultaneously. Refer to Figures 5 and 6 for illustrations of the input circuitry for one channel of the NI 9235/9236.

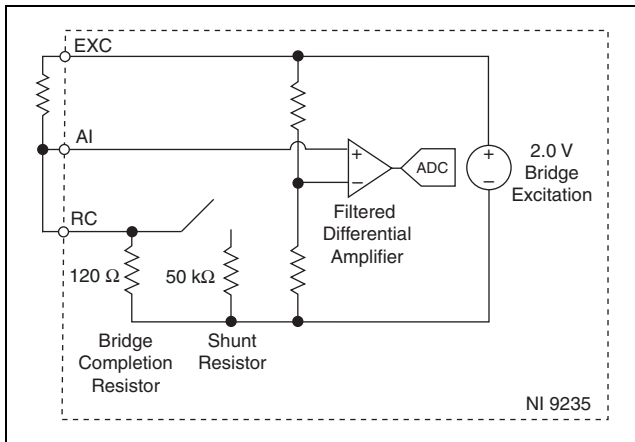


Figure 5. Input Circuitry for One Channel of the NI 9235

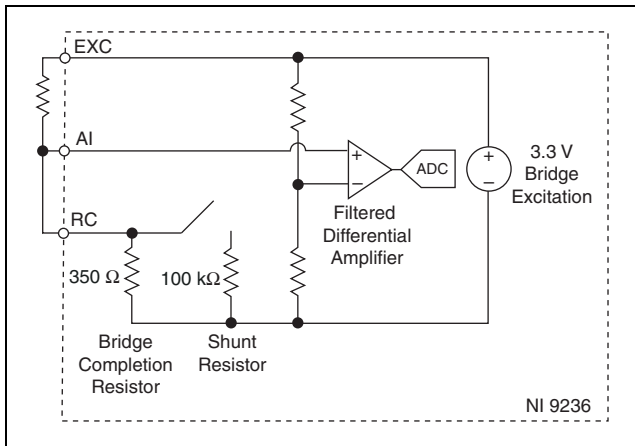


Figure 6. Input Circuitry for One Channel of the NI 9236

The NI 9235/9236 also includes filters to prevent aliasing. The filters on the NI 9235/9236 filter according to the sampling rate. Refer to the [Understanding NI 9235/9236 Filtering](#) section for more information about filtering.

Quarter-bridge measurements are inherently sensitive to accuracy degradation due to the lead resistance of wiring from the sensor to the measurement device. For a given change in the gage resistance, the total effective resistance changes slightly less. Accordingly, the measured mV/V reading is less than its true value. However, you can use shunt calibration to quantify the lead wire desensitization, and can then design the software application to correct subsequent readings for this gain error. The gain error caused by a lead wire equals R_L/R_G , where R_L is the lead wire resistance, and R_G is the quarter-bridge completion resistance.

Shunt Calibration

The NI 9235/9236 shunt calibration circuitry consists of a precision resistor and a software-controlled switch, connected across the internal quarter-bridge completion resistor. Refer to the software help for information about enabling the shunt calibration switch for the NI 9235/9236. Each input channel has a unique shunt calibration resistor that can operate independently, as shown in Figures 5 and 6.

Shunt calibration simulates strain input by changing the resistance of an arm in the bridge by a known amount. By shunting, or connecting, a large resistor across one arm of the bridge, a specific change occurs in the bridge voltage ratio. With the connected sensor in a stable, typically unloaded, state, you can measure the output of the bridge before and after the shunt calibration. You can compare the measured reading change to the shunt calibration output value to verify system setup or compensate for quarter-bridge lead wire desensitization error. Refer to the *Specifications* section for the shunt calibration output value. Visit ni.com/info and enter `lwcomp` for information about lead wire compensation.

Excitation Voltage

The NI 9235/9236 provides a constant excitation supply voltage to each channel. The excitation supply provides sufficient output current to power all eight channels at minimum resistance. The excitation supply retains regulation even if one channel experiences a gage short. If more than one channel has a gage short, the excitation supply enters a current limit state and the excitation voltage falls accordingly.

Understanding NI 9235/9236 Filtering

The NI 9235/9236 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The three important bandwidths to consider are the passband, the stopband, and the alias-free bandwidth.

The NI 9235/9236 represents signals within the passband, as quantified primarily by passband flatness and phase nonlinearity. All signals that appear in the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

Passband

The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The digital filters of the NI 9235/9236 adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate. Figure 7 shows typical passband flatness for the 10 kS/s data rate.

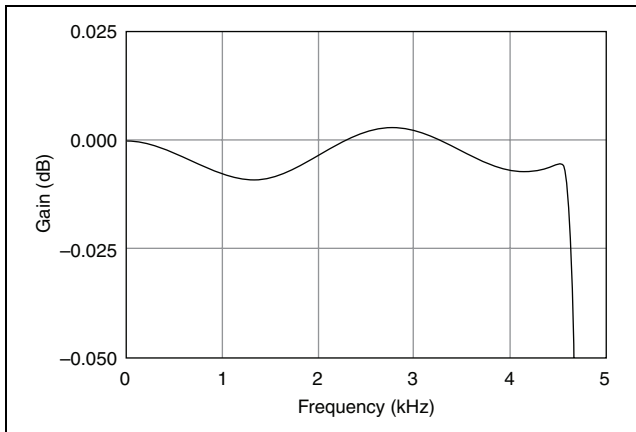


Figure 7. Typical Passband Response for the NI 9235/9236

Stopband

The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely with the data rate. The stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband.

Alias-Free Bandwidth

Any signal that appears in the alias-free bandwidth of the NI 9235/9236 is not an aliased artifact of signals at a higher frequency. The alias-free bandwidth is defined by the ability of the filter to reject frequencies above the stopband frequency and equals the data rate minus the stopband frequency.

Understanding NI 9235/9236 Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_s) of the NI 9235/9236. The NI 9235/9236 includes an internal master timebase with a frequency of 12.8 MHz, but the module also can accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI 9235/9236 with other modules that use master timebases to control sampling, all of

the modules must share a single master timebase source. Refer to the software help for information about configuring the master timebase source for the NI 9235/9236. Visit ni.com/info and enter `cseriesdoc` for information about C Series documentation.

The following equation provides the available data rates of the NI 9235/9236:

$$f_s = \frac{f_M \div 256}{n}$$

where n is any integer in the set {2; 4, 5, ..., 63}.

However, the data rate must remain within the appropriate data rate range. Refer to the *Specifications* section for more information about the data rate range. When using the internal master timebase of 12.8 MHz, the result is data rates of 10 kS/s, 8.333 kS/s, 7.143 kS/s, and so on down to 794 S/s, depending on the value of n . When using an external timebase with a frequency other than 12.8 MHz, the NI 9235/9236 has a different set of data rates.



Note The cRIO-9151 R Series Expansion chassis does not support sharing timebases between modules.

Sleep Mode

This module supports a low-power sleep mode. Support for sleep mode at the system level depends on the chassis that the module is plugged into. Refer to the chassis manual for information about support for sleep mode. If the chassis supports sleep mode, refer to the software help for information about enabling sleep mode. Visit ni.com/info and enter `cseriesdoc` for information about C Series documentation.

Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system consumes minimal power and may dissipate less heat than it does in normal mode. Refer to the *Specifications* section for more information about power consumption and thermal dissipation.

Specifications

The following specifications are typical for the range -40 to 70 °C unless otherwise noted. The specifications are the same for the NI 9235 and the NI 9236 unless otherwise noted.

Input Characteristics

Number of channels	8 analog input channels
Quarter-bridge completion	
NI 9235	120 Ω , 10 ppm/°C max
NI 9236	350 Ω , 10 ppm/°C max
ADC resolution	24 bits
Type of ADC	Delta-Sigma (with analog prefiltering)
Sampling mode	Simultaneous
Internal master timebase (f_M)	
Frequency	12.8 MHz
Accuracy	± 100 ppm max

Data rate range (f_s) using internal master timebase

Minimum 794 S/s

Maximum 10 kS/s

Data rate range (f_s) using external master timebase

Minimum 195.3125 S/s

Maximum 10.547 kS/s

Data rates¹ (f_s) $\frac{f_M \div 256}{n}$, $n = \{2; 4, 5, \dots, 63\}$

Full-scale range ± 29.4 mV/V
(+62,500 $\mu\epsilon$ / -55,500 $\mu\epsilon$)

Scaling coefficient 3.5062 nV/V per LSB

Overvoltage protection
between any two terminals ± 30 V

¹ The data rate must remain within the appropriate data rate range. Refer to the [Understanding NI 9235/9236 Data Rates](#) section for more information.

Accuracy, NI 9235

Measurement Conditions	Percent of Reading* (Gain Error)	Percent of Range ^{†, ‡} (Offset Error)	
		30 days after cal. (±5 °C)	1 year after cal. (±5 °C)
Calibrated typ (25 °C, ±5 °C)	0.02%	0.1%	0.15%
Calibrated max (-40 to 70 °C)	0.07%	0.17%	0.4%
Uncalibrated typ (25 °C, ±5 °C)	0.15%	1.25%	
Uncalibrated max (-40 to 70 °C)	0.53%	2.14%	
<p>* Exclusive of lead wire desensitization error.</p> <p>† Range equals 29.4 mV/V.</p> <p>‡ Calibrated errors represent offset stability following unstrained measurement. Errors include the effect of completion resistor tolerance and drift.</p>			

Stability, NI 9235

Gain drift.....	6 ppm/°C
Offset drift.....	2.2 μV/V/°C

Accuracy, NI 9236

Measurement Conditions	Percent of Reading* (Gain Error)	Percent of Range ^{†, ‡} (Offset Error)	
		30 days after cal. ($\pm 5\text{ }^{\circ}\text{C}$)	1 year after cal. ($\pm 5\text{ }^{\circ}\text{C}$)
Calibrated typ ($25\text{ }^{\circ}\text{C}$, $\pm 5\text{ }^{\circ}\text{C}$)	0.02%	0.08%	0.14%
Calibrated max (-40 to $70\text{ }^{\circ}\text{C}$)	0.07%	0.16%	0.39%
Uncalibrated typ ($25\text{ }^{\circ}\text{C}$, $\pm 5\text{ }^{\circ}\text{C}$)	0.15%	0.79%	
Uncalibrated max (-40 to $70\text{ }^{\circ}\text{C}$)	0.53%	1.67%	
<p>* Exclusive of lead wire desensitization error.</p> <p>† Range equals 29.4 mV/V.</p> <p>‡ Calibrated errors represent offset stability following unstrained measurement. Errors include the effect of completion resistor tolerance and drift.</p>			

Stability, NI 9236

Gain drift..... 6 ppm/ $^{\circ}\text{C}$

Offset drift..... 1.7 $\mu\text{V}/\text{V}/^{\circ}\text{C}$

Channel-to-channel matching (calibrated)

Input Signal Frequency (f_{in})	Gain		Phase
	Typical	Maximum	Maximum
0 to 1 kHz	0.08%	0.11%	$0.34^\circ/\text{kHz} \cdot f_{in}$
0 to 4 kHz	0.17%	0.32%	

Phase nonlinearity

$$f_{in} = 0 \text{ to } 1 \text{ kHz} \dots\dots\dots \pm 0.002^\circ$$

$$f_{in} = 0 \text{ to } 4 \text{ kHz} \dots\dots\dots \pm 0.1^\circ$$

$$\text{Input delay} \dots\dots\dots 38.2/f_s + 11 \mu\text{s}$$

Passband

$$\text{Frequency} \dots\dots\dots 0.45 \cdot f_s$$

$$\text{Flatness } (f_s = 10 \text{ kS/s}) \dots\dots\dots 33 \text{ mdB max}$$

Stopband

$$\text{Frequency} \dots\dots\dots 0.55 \cdot f_s$$

$$\text{Rejection} \dots\dots\dots 100 \text{ dB}$$

Alias-free bandwidth	$0.45 \cdot f_s$
Oversample rate	$64 \cdot f_s$
Rejection at oversample rate ¹ ($f_s = 10$ kS/s)	80 dB @ 640 kHz
Input noise	
$f_s = 1$ kS/s	
NI 9235	$0.38 \mu\text{V}/V_{\text{rms}}$
NI 9236	$0.25 \mu\text{V}/V_{\text{rms}}$
$f_s = 10$ kS/s	
NI 9235	$0.85 \mu\text{V}/V_{\text{rms}}$
NI 9236	$0.5 \mu\text{V}/V_{\text{rms}}$
SFDR (1 kHz, -60 dBFS)	
NI 9235.....	110 dB
NI 9236.....	115 dB
THD (1 kHz, -20 dBFS)	
NI 9235.....	-90 dB
NI 9236.....	-95 dB

¹ Rejection by analog prefilter of signal frequencies at oversample rate.

Crosstalk ($f_{in} = 1$ kHz)	-100 dB
Common-mode voltage, all signals to earth ground.....	± 60 VDC
CMRR ($f_{in} = 0$ to 60 Hz)	
NI 9235.....	120 dB
NI 9236.....	110 dB
MTBF	566,796 hours at 25 °C; Bellcore Issue 2, Method 1, Case 3, Limited Part Stress Method



Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Shunt Calibration Characteristics

Shunt calibration accuracy

Measurement Conditions	NI 9235 Percent of Reading (Gain Error)	NI 9236 Percent of Reading (Gain Error)
Typical (25 °C, ±5 °C)	0.09%	0.07%
Maximum (-40 to 70 °C)	0.22%	0.2%

Resistance

NI 9235..... 50 kΩ

NI 9236..... 100 kΩ

Output value

NI 9235..... -599.28 μV/V

NI 9236..... -873.47 μV/V

Temperature drift 15 ppm/°C

Method..... Shunt across completion resistor

Excitation Characteristics

Excitation type Constant voltage

Excitation value

NI 9235 2.0 V \pm 1%

NI 9236 3.3 V \pm 1%

Maximum output current

NI 9235 80 mA

NI 9236 46 mA

Power Requirements

Power consumption from chassis

NI 9235

Active mode 735 mW max

Sleep mode 25 μ W max

NI 9236

Active mode 675 mW max

Sleep mode 25 μ W max

Thermal dissipation (at 70 °C)

NI 9235

Active mode 735 mW max

Sleep mode..... 25 μ W max

NI 9236

Active mode 675 mW max

Sleep mode..... 25 μ W max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Spring-terminal wiring..... 18 to 28 AWG copper
conductor wire with 7 mm
(0.28 in.) of insulation
stripped from the end

Weight..... 153 g (5.4 oz)

Safety

Safety Voltages

Connect only voltages that are within the following limits.

Between any two terminals..... ± 30 V max

Isolation

Channel-to-channel None

Channel-to-earth ground

Continuous 60 VDC,

Measurement Category I

Withstand 1,000 V_{rms}, verified by a 5 s dielectric withstand test

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as *MAINS* voltage. *MAINS* is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.



Caution Do *not* connect the NI 9235/9236 to signals or use for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1



Note For UL and other safety certifications, refer to the product label or visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Hazardous Locations

U.S. (UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, AEx nA IIC T4
Canada (C-UL)	Class I, Division 2, Groups A, B, C, D, T4; Class I, Zone 2, Ex nA IIC T4
Europe (DEMKO).....	Ex nA IIC T4

Environmental

National Instruments C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature

(IEC 60068-2-1, IEC 60068-2-2) -40 to 70 °C

Storage temperature

(IEC 60068-2-1, IEC 60068-2-2) -40 to 85 °C

Ingress protection..... IP 40

Operating humidity

(IEC 60068-2-56)..... 10 to 90% RH,
noncondensing

Storage humidity

(IEC 60068-2-56)..... 5 to 95% RH,
noncondensing

Maximum altitude..... 2,000 m

Pollution Degree (IEC 60664) 2

Shock and Vibration

To meet these specifications, you must panel mount the system and use the NI 9965 backshell to protect the connections.

Operating vibration

Random (IEC 60068-2-64)..... 5 g_{rms}, 10 to 500 Hz

Sinusoidal (IEC 60068-2-6) 5 g, 10 to 500 Hz

Operating shock

(IEC 60068-2-27)..... 30 g, 11 ms half sine,
50 g, 3 ms half sine,
18 shocks at 6 orientations

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Industrial Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A



Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European directives, as amended for CE markings, as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)



EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

电子信息产品污染控制管理办法（中国 RoHS）



中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9235/9236 at ni.com/calibration.

Calibration interval 1 year

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at ni.com/support

and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 662 457990-0,
Belgium 32 (0) 2 757 0020, Brazil 55 11 3262 3599,
Canada 800 433 3488, China 86 21 5050 9800,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 358 (0) 9 725 72511, France 01 57 66 24 24,
Germany 49 89 7413130, India 91 80 41190000,
Israel 972 3 6393737, Italy 39 02 41309277, Japan 0120-527196,
Korea 82 02 3451 3400, Lebanon 961 (0) 1 33 28 28,
Malaysia 1800 887710, Mexico 01 800 010 0793,
Netherlands 31 (0) 348 433 466, New Zealand 0800 553 322,
Norway 47 (0) 66 90 76 60, Poland 48 22 3390150,
Portugal 351 210 311 210, Russia 7 495 783 6851,
Singapore 1800 226 5886, Slovenia 386 3 425 42 00,
South Africa 27 0 11 805 8197, Spain 34 91 640 0085,
Sweden 46 (0) 8 587 895 00, Switzerland 41 56 2005151,
Taiwan 886 02 2377 2222, Thailand 662 278 6777,
Turkey 90 212 279 3031, United Kingdom 44 (0) 1635 523545

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